



A Terrestrial Surface CDR for Global Change Studies

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^(g) Sigma Space

Overview

- Objectives

to develop, produce and distribute a multi-instrument global long term coarse spatial resolution data record for use in climate studies.

- Development of

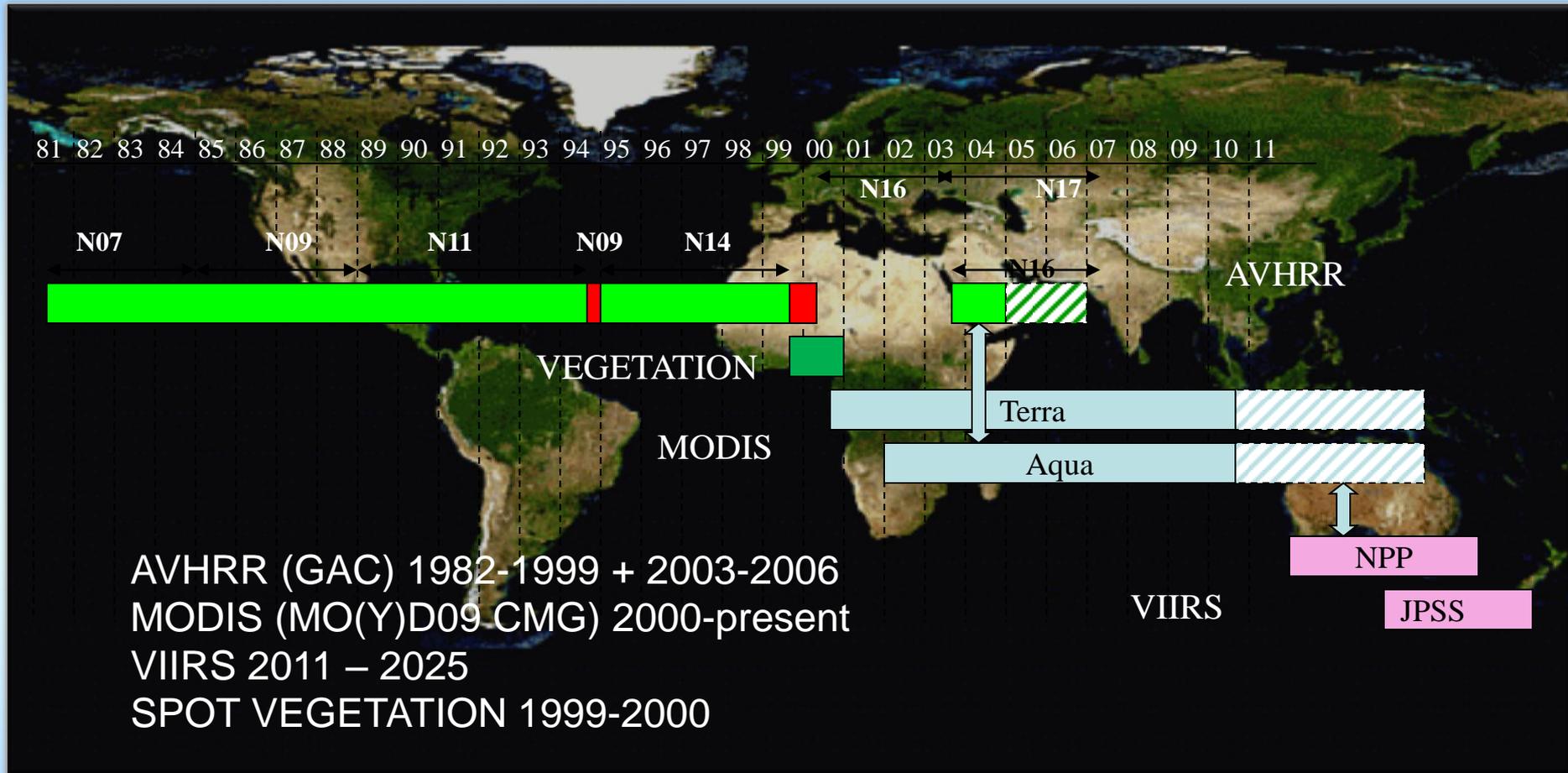
- Surface Reflectance
 - Vegetation Index (VI)
 - LAI / fAPAR
- } from the multispectral Imager(s) Solar Reflectance

- Source (time-dependent)

-

Land Climate Data Record

Multi instrument/Multi sensor Science Quality Data Records used to quantify trends and changes



Emphasis on data consistency – characterization rather than degrading/smoothing the data

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- Source (time-dependent)

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- Deliverables for the entire records (1982-Present)

- ECVs (Essential Climate Variables) addressed

- Surface reflectance input for Albedo ECV
- VI and LAI / fAPAR are ECVs

- User community

Land Cover Land Use Change

Terrestrial Ecology

carbon models

Agriculture application Food security

global vegetation dynamics models

...

Land Climate Data Record (Approach)

Needs to address geolocation, calibration, atmospheric/BRDF correction issues

DN Value

TOA reflectance

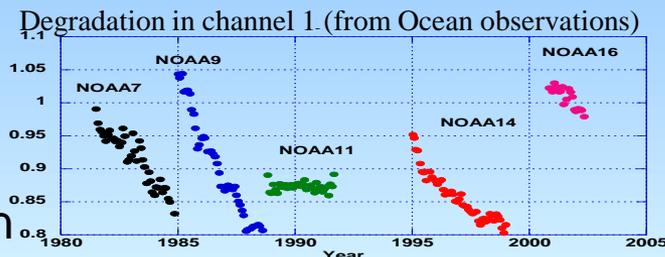
TOC reflectance

Normalized TOC reflectance

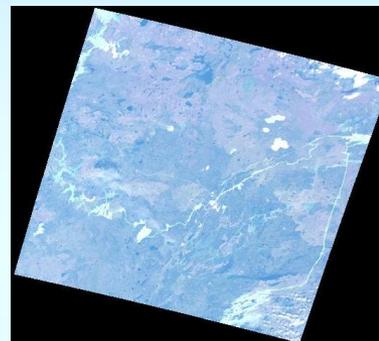
ECVs



Calibration

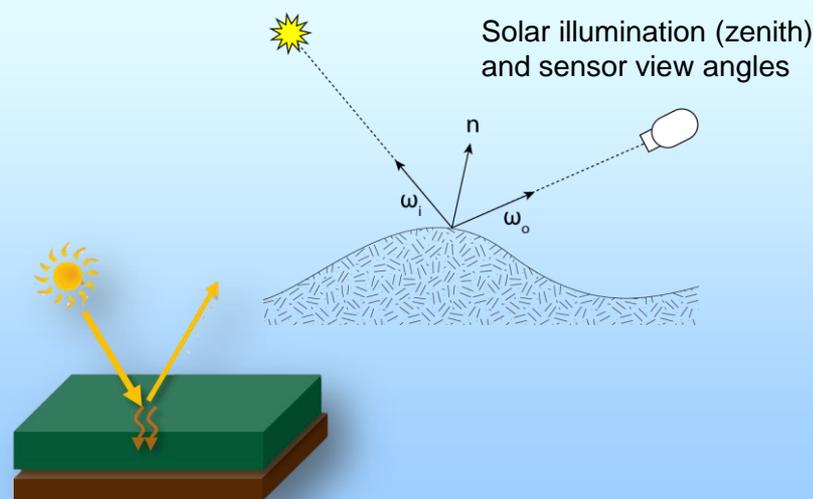


Atmospheric Correction

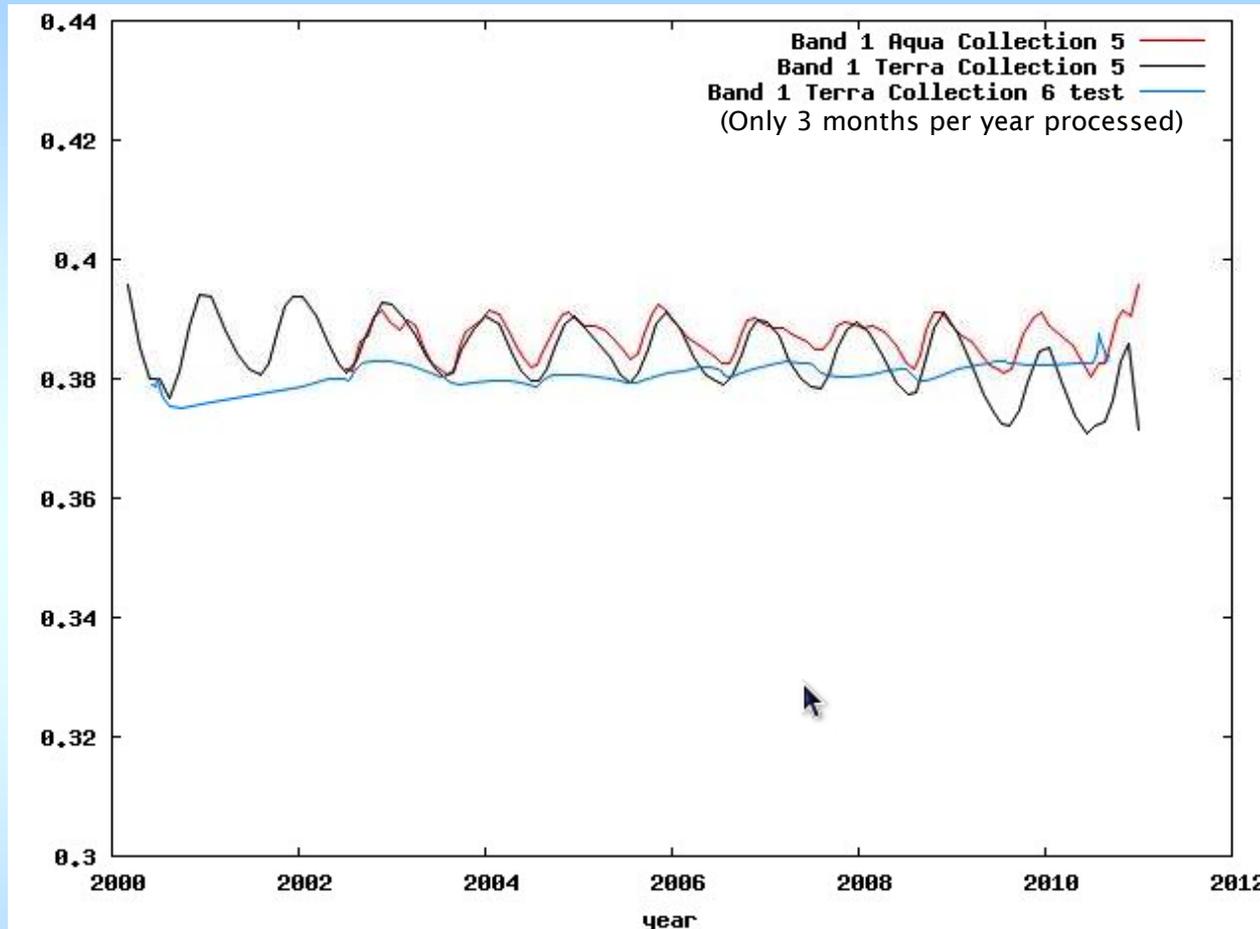


BRDF Correction

Biophysical Models inversion

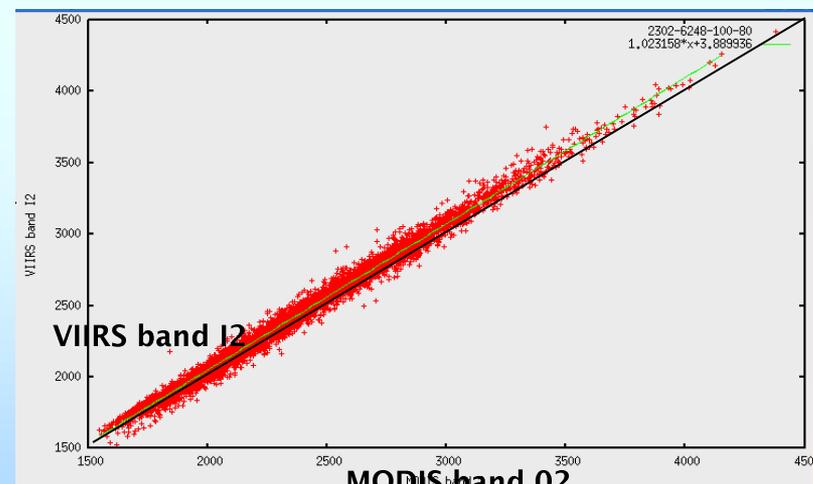
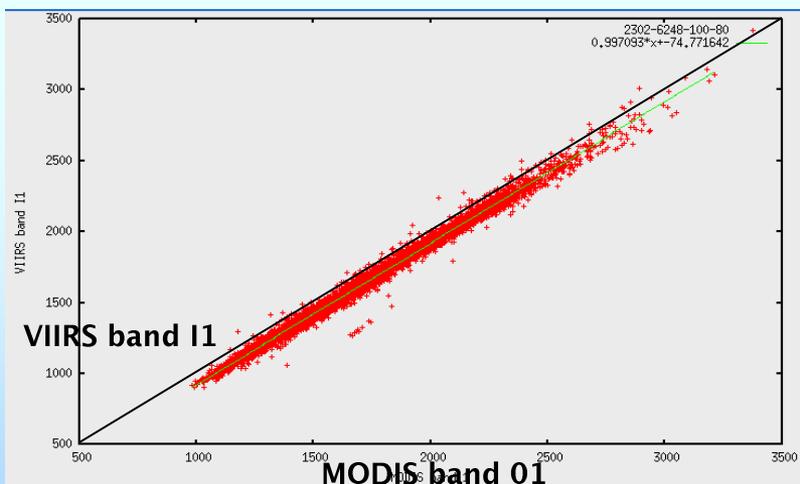
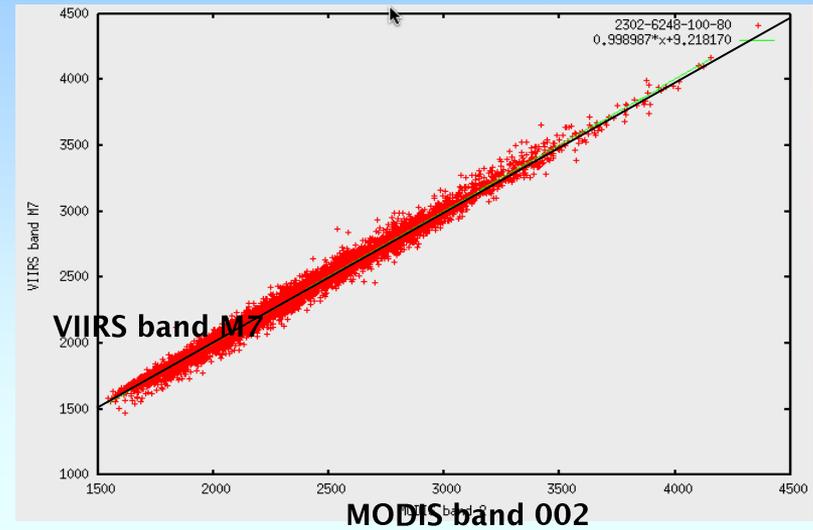
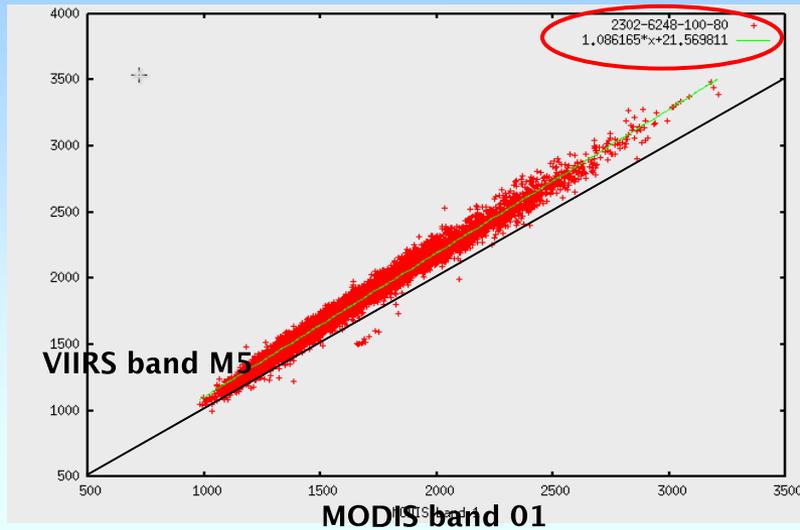


Calibration of MODIS Aqua/Terra



The Collection 5 calibration induced a difference between Terra and Aqua of 1.5% (in band 1) starting in 2009. The Collection 6 LUT will fix the problem. This data were generated using the calibration method described in Vermote and El Saleous (2006).

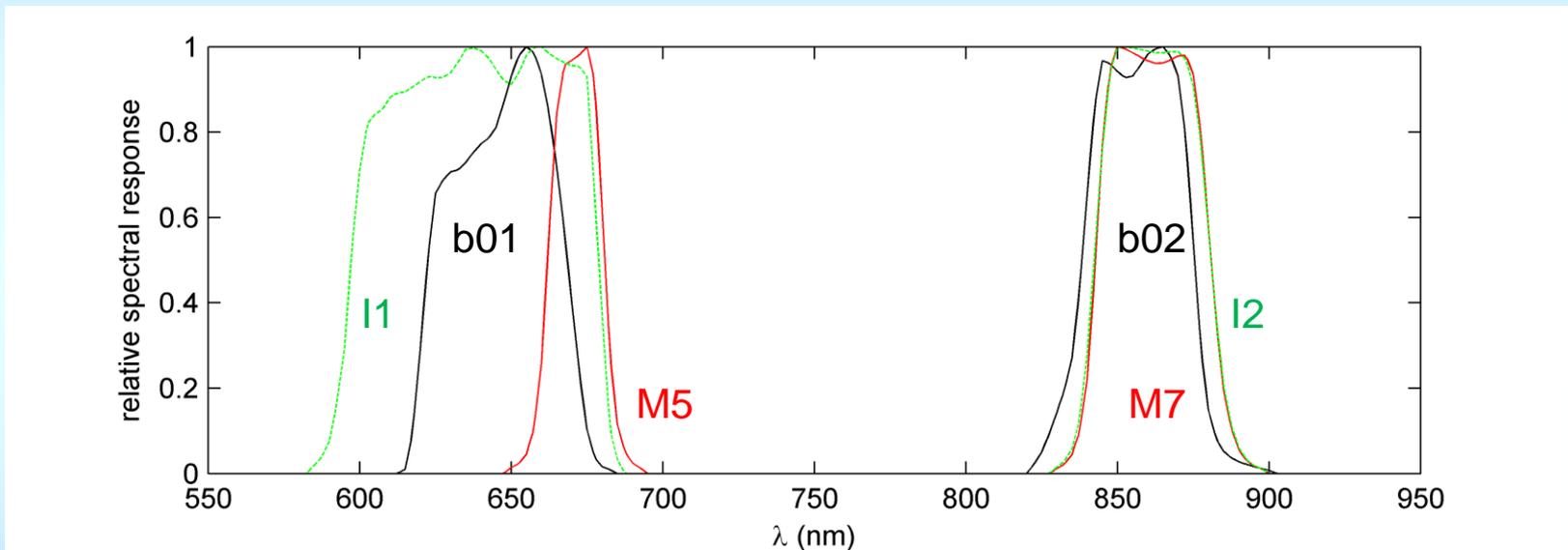
Cross-Calibration of VIIRS 1/2



Comparison of the VIIRS and Aqua SR product corrected for BRDF effect. Bands M7, I2 and I1 compare well with Aqua band 1 and 2 (ratio of 0.999 for M7, 1.023 for I2 and 0.997 for I1). The ratio between M5 and Modis band 1 is 1.086 and this is attributed to spectral difference between the two band

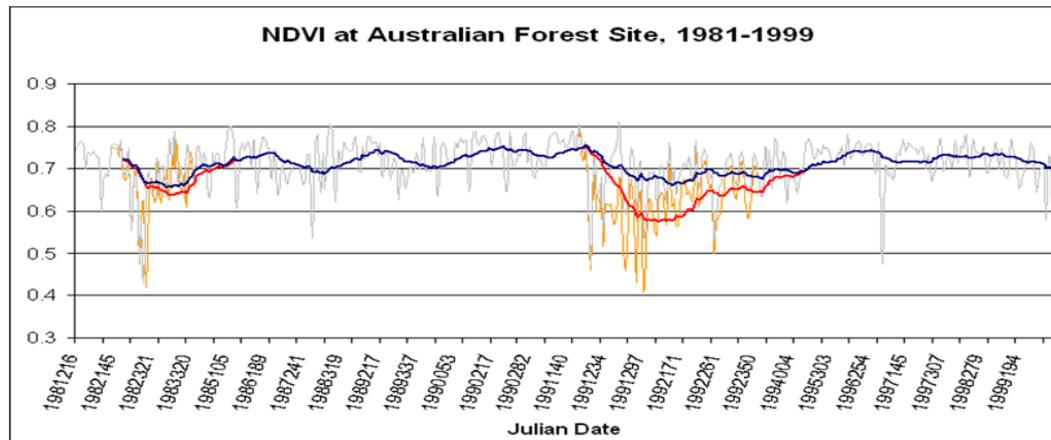
Cross-Calibration of VIIRS 2/2

VIIRS (green and red) and MODIS (black) spectral bands

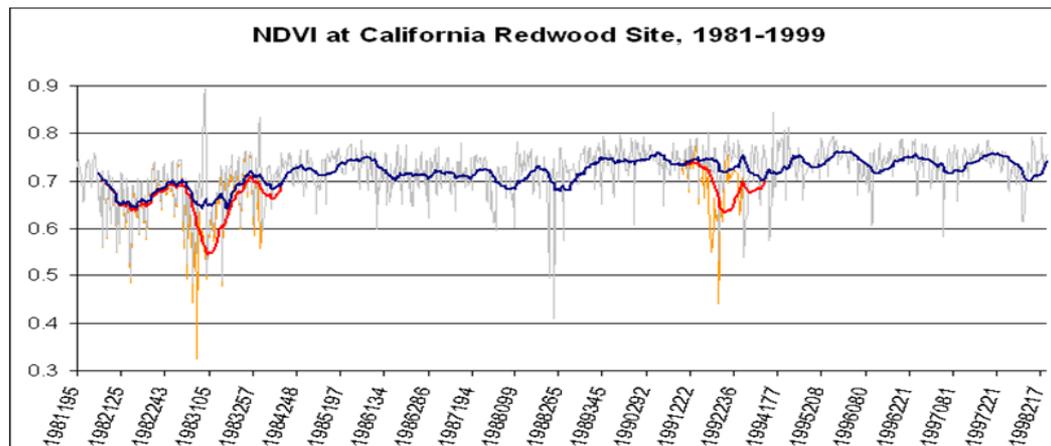


Comparison of VIIRS and Aqua spectral response for
VIIRS M5, M7, I1, I2 and MODIS band 1 and 2

Atmospheric corrections: Validation of Stratospheric aerosol correction on time series



Comparison of the NDVI time series observed at an Australian evergreen forest site with (blue curve) or without (red curve) the stratospheric aerosol correction (using the optical thickness data from figure 7b). The impact of Pinatubo eruption (1991) ~0.1 decrease in NDVI is clearly visible.



Comparison of the NDVI time series observed at a USA West coast evergreen forest site with (blue curve) or without (red curve) the stratospheric aerosol correction (using the optical thickness data from figure 7b). The impacts of the Mt. El Chichon eruption (1982) and to a lesser extent the Mt. Pinatubo eruption (1991) are visible.

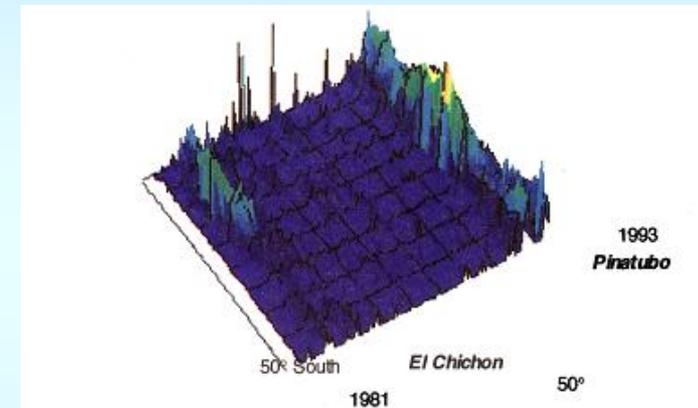


Figure 7b: Monthly average of the stratospheric aerosol optical depth derived from the AVHRR data showing the major eruptions of El Chichon (1982) and Pinatubo (1991) from [Vermote et al., 1997b].

Applying MODIS BRDF correction and atmospheric correction to account for AVHRR orbital drift

Impact of Atmospheric and BRDF effect on AVHRR Data

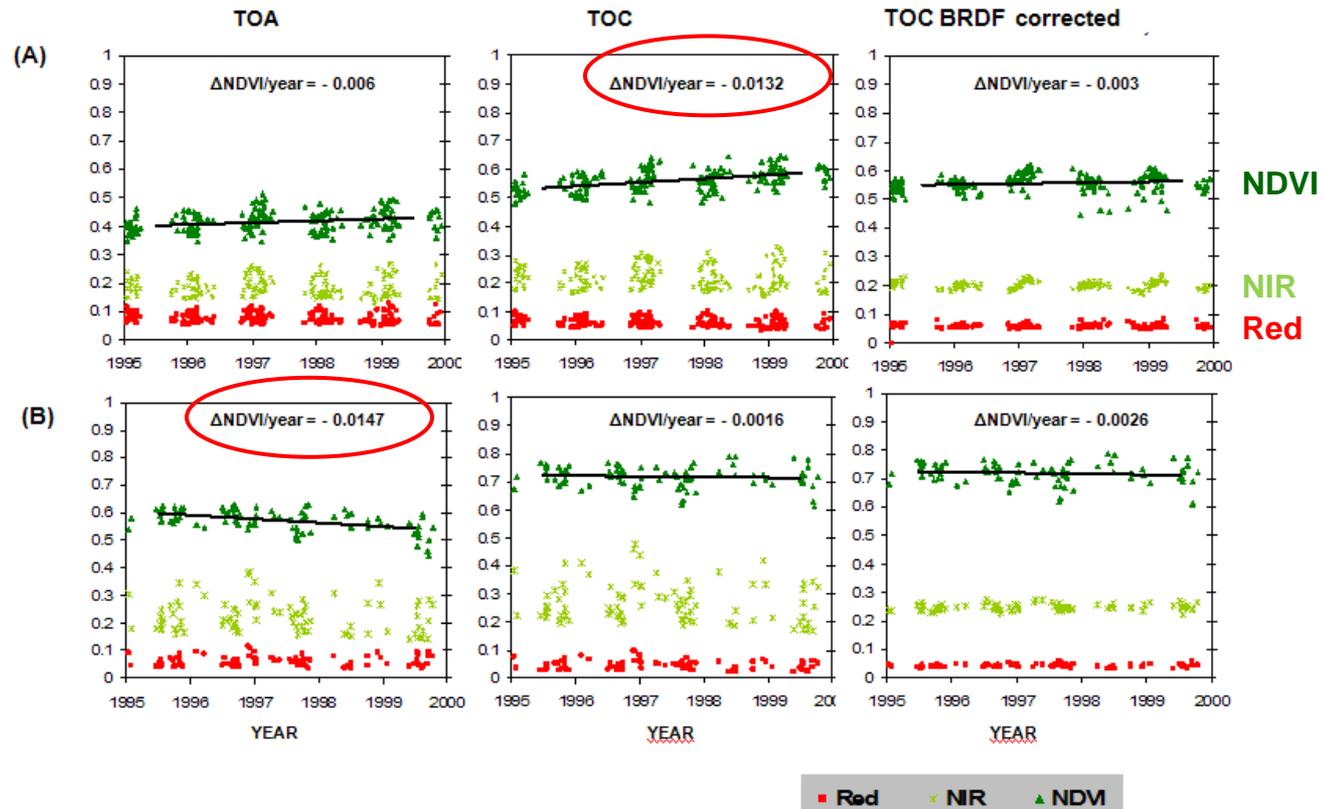
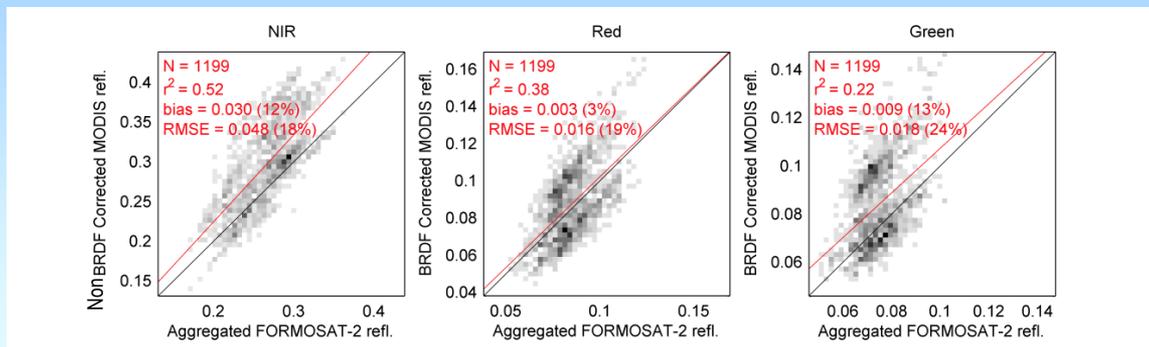
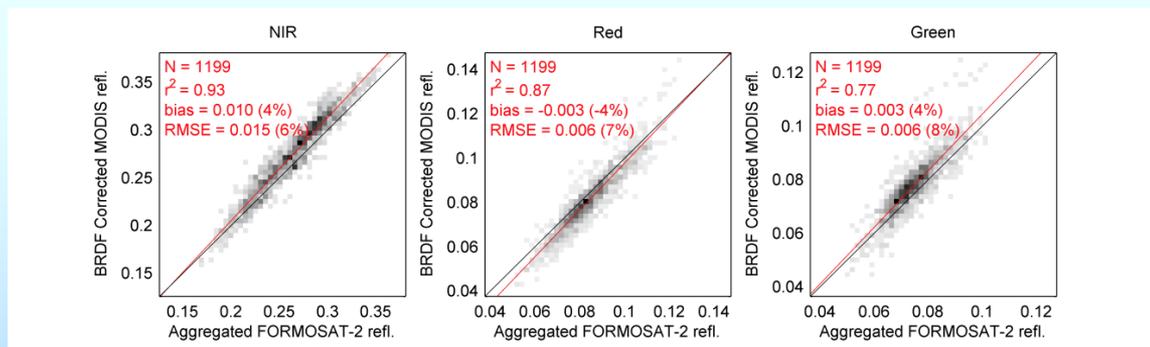


Figure 2a: Impact of the orbital drift on NOAA14 (1995-1999) data for two evergreen forest sites in Australia, (A) with 50% tree cover, (B) with 95% tree cover. TOA is top of the atmosphere, TOC is the Top of the canopy, BRDF corrected uses the correction described in 2.3.5.

Cross-comparison of MODIS SR with product derived using independent approach 1/2



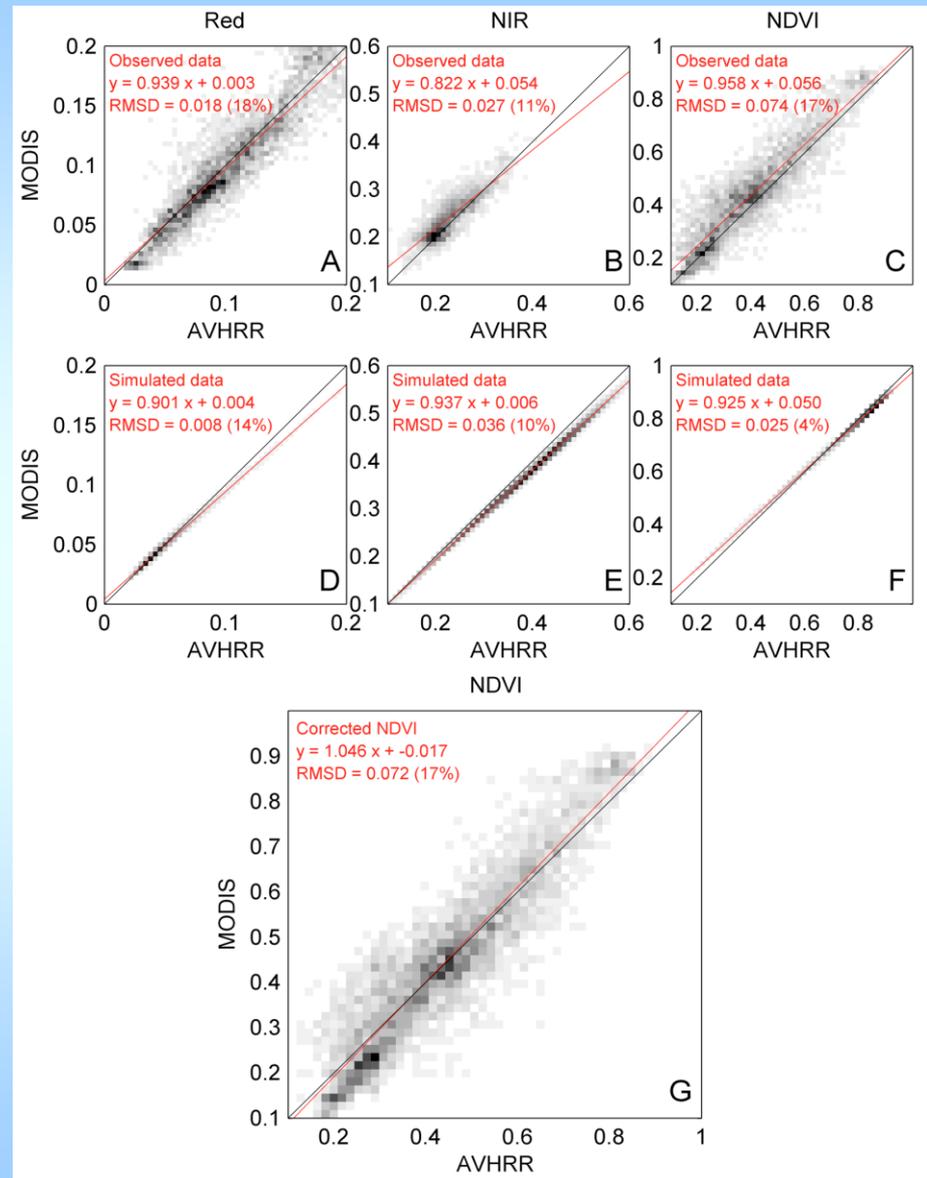
Comparison of aggregated FORMOSAT-2 reflectance and MODIS reflectance. No BRDF correction. Density function from light grey (minimum) to black (maximum); white = no data.



Comparison of aggregated FORMOSAT-2 reflectance and BRDF corrected MODIS reflectance. Corrections were performed with Vermote al. (2009) method using for each day of acquisition, the angular configuration of FORMOSAT-2 data.

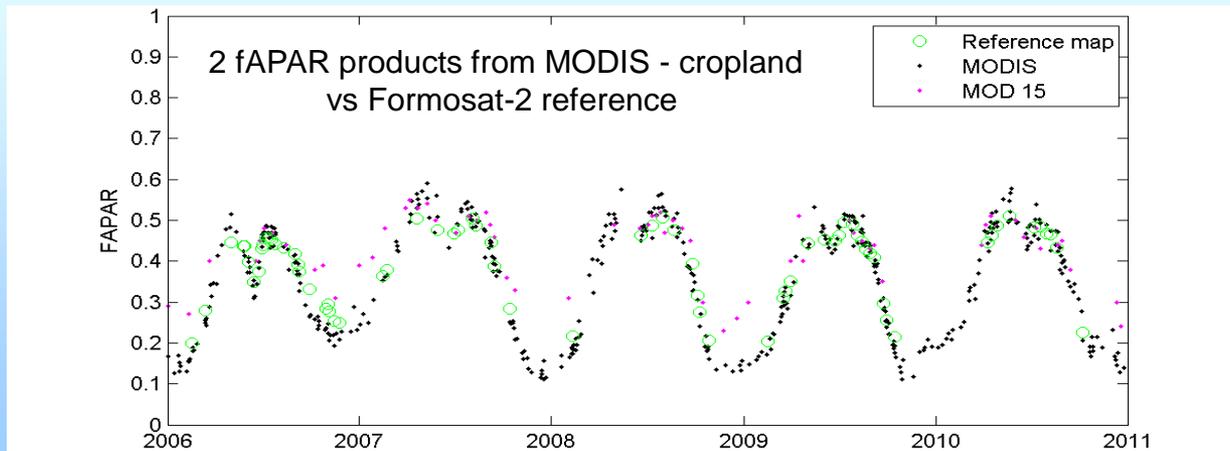
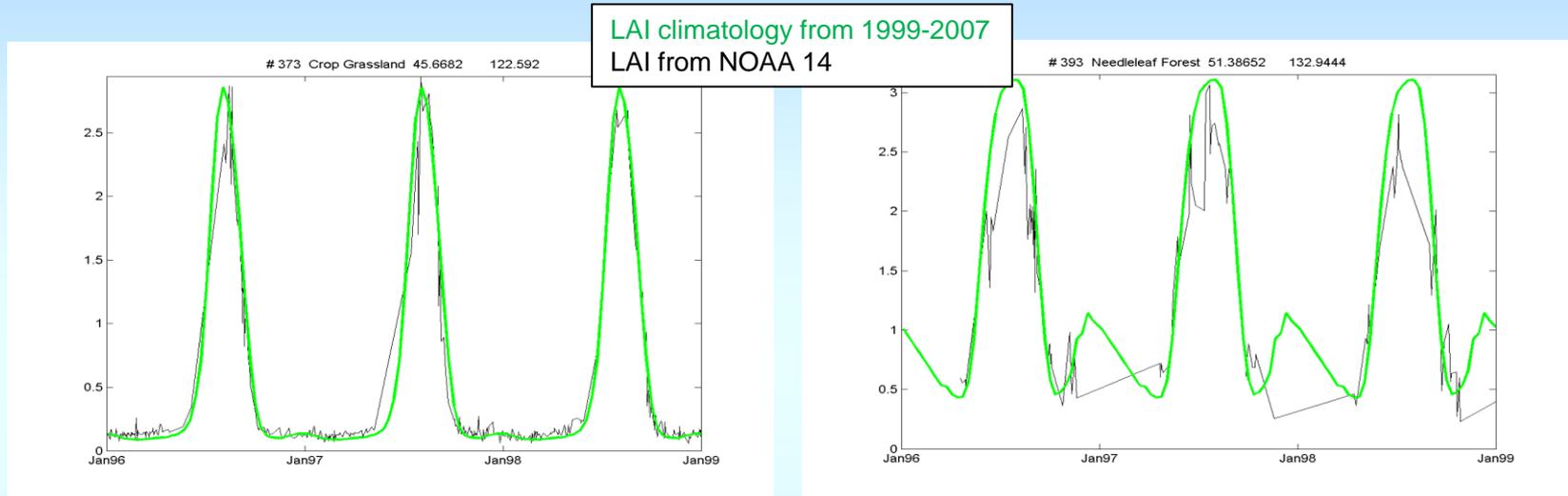
Using Direct comparison with MODIS Aqua for validation

Comparison of MODIS Aqua and NOAA16 AVHRR data, A (Red) ,B (NIR) ,C (NDVI) are observed over AERONET sites for 2003-2004, D (Red), E(NIR), F(NDVI) are simulated using a vegetation model that account for spectral difference between MODIS and AVHRR bands. G shows over the AERONET sites MODIS NDVI versus corrected AVHRR NDVI computed from spectrally adjusted AVHRR surface reflectance.



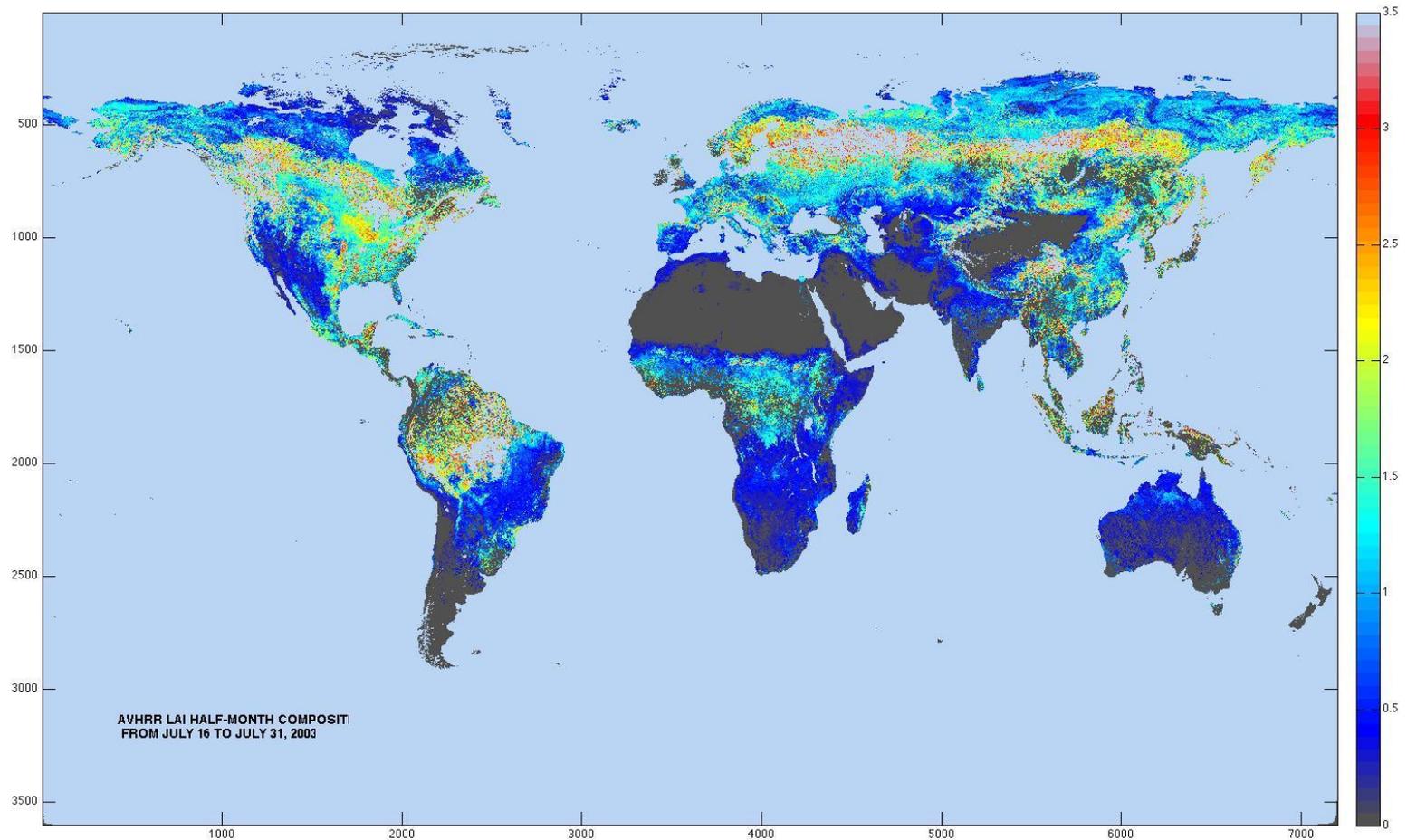
TCDR LAI/fAPAR product from AVHRR/MODIS (in progress), Fred Baret – INRA

LAI comparison NOAA 14 and European CYCLOPE LAI
Two examples extracted from 420 sites...



TCDR LAI/FPAR product from AVHRR/MODIS

Ranga Myneni- Boston University

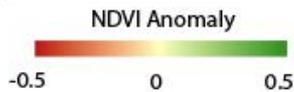
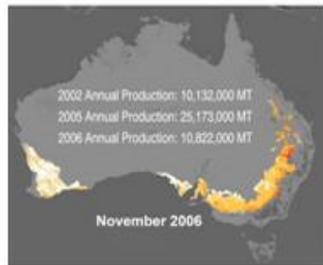
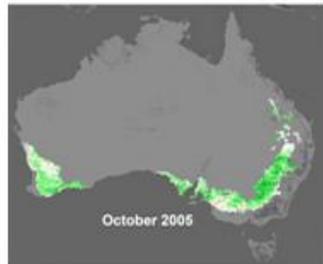
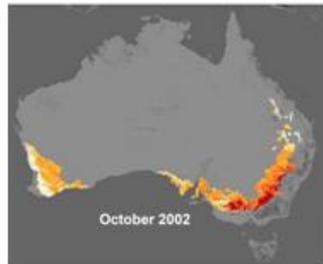


SOME APPLICATION EXAMPLES...

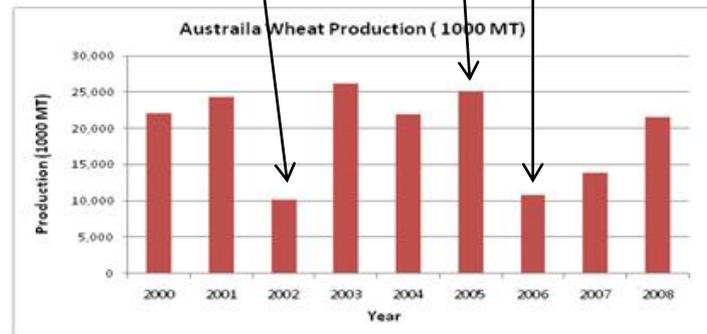
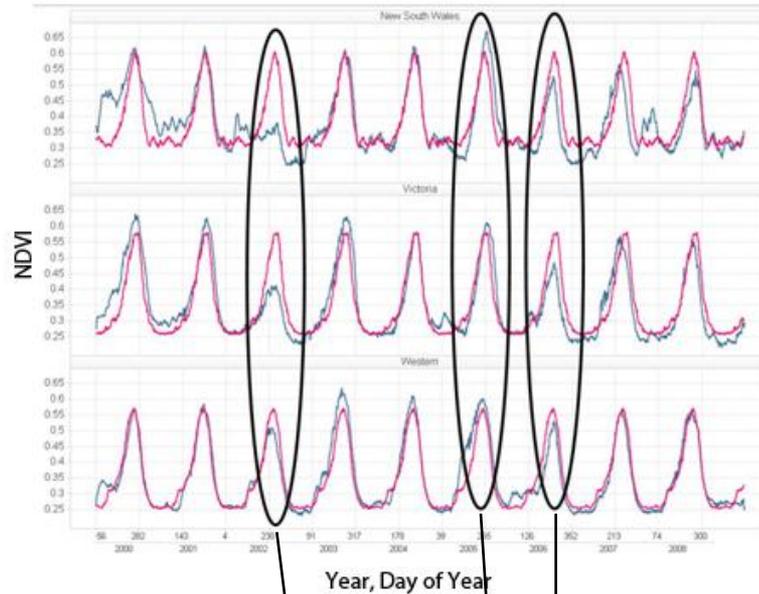
1. Crop yields estimation
2. Droughts monitoring
3. Forest Cover Changes monitoring

Application to agriculture/drought Monitoring

Australia NDVI Anomalies



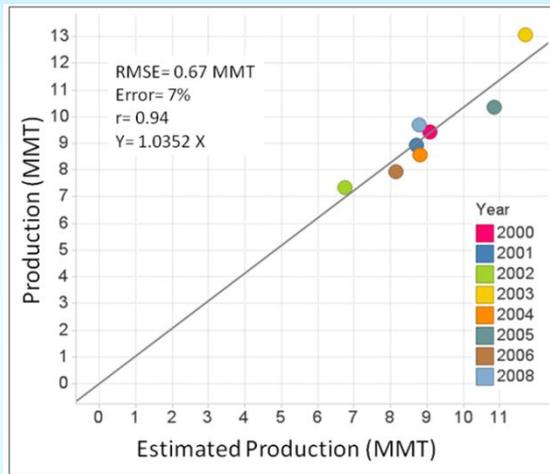
Daily NDVI (blue) vs. median NDVI (pink) for 3 wheat regions in Australia: 2000-2008



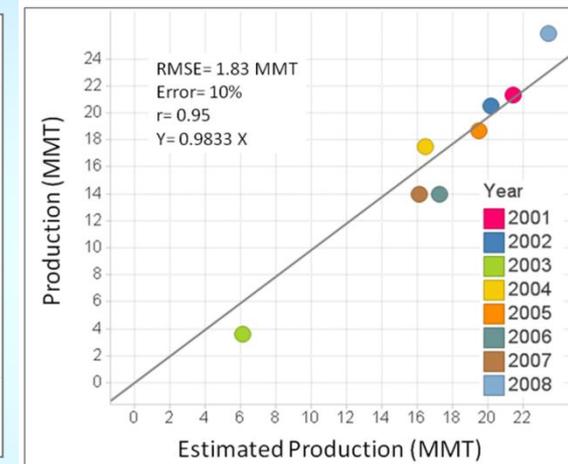
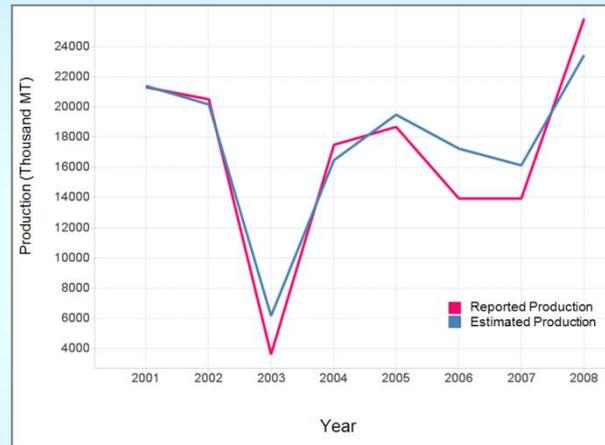
Becker-Reshef, I., et al. (2010b), Monitoring Global Croplands with Coarse Resolution Earth Observations: The Global Agriculture Monitoring (GLAM) Project, *Remote Sensing*, 2(6), 1589-1609.

Application to Agriculture: Yield/Production prediction

Kansas: Wheat

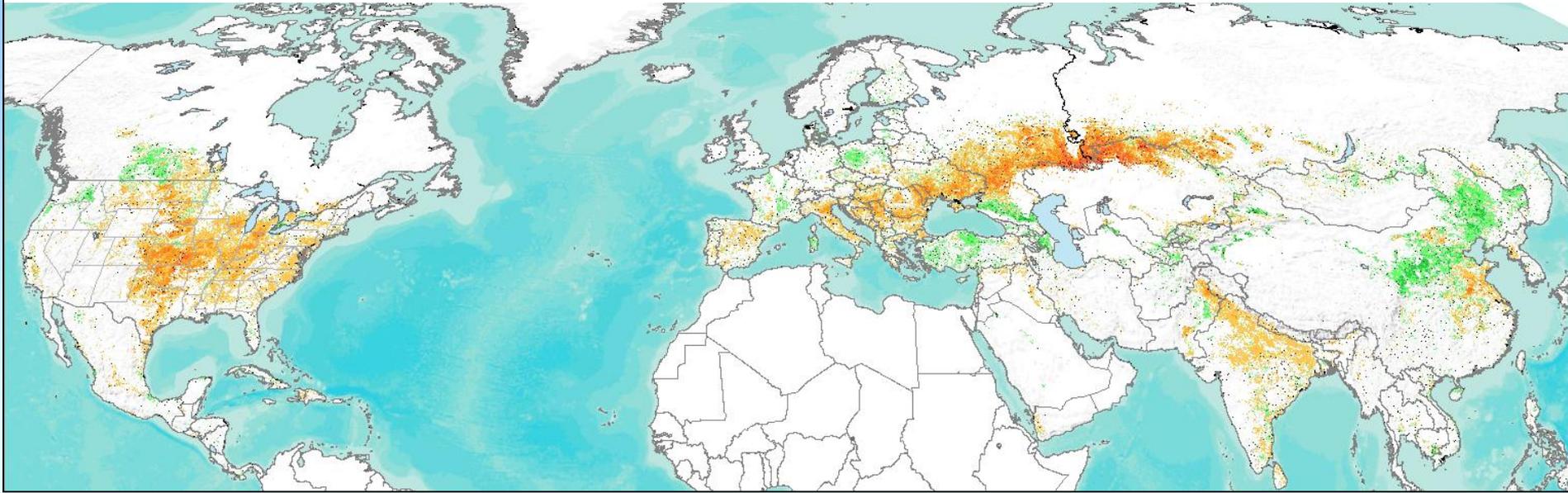


Ukraine: Wheat

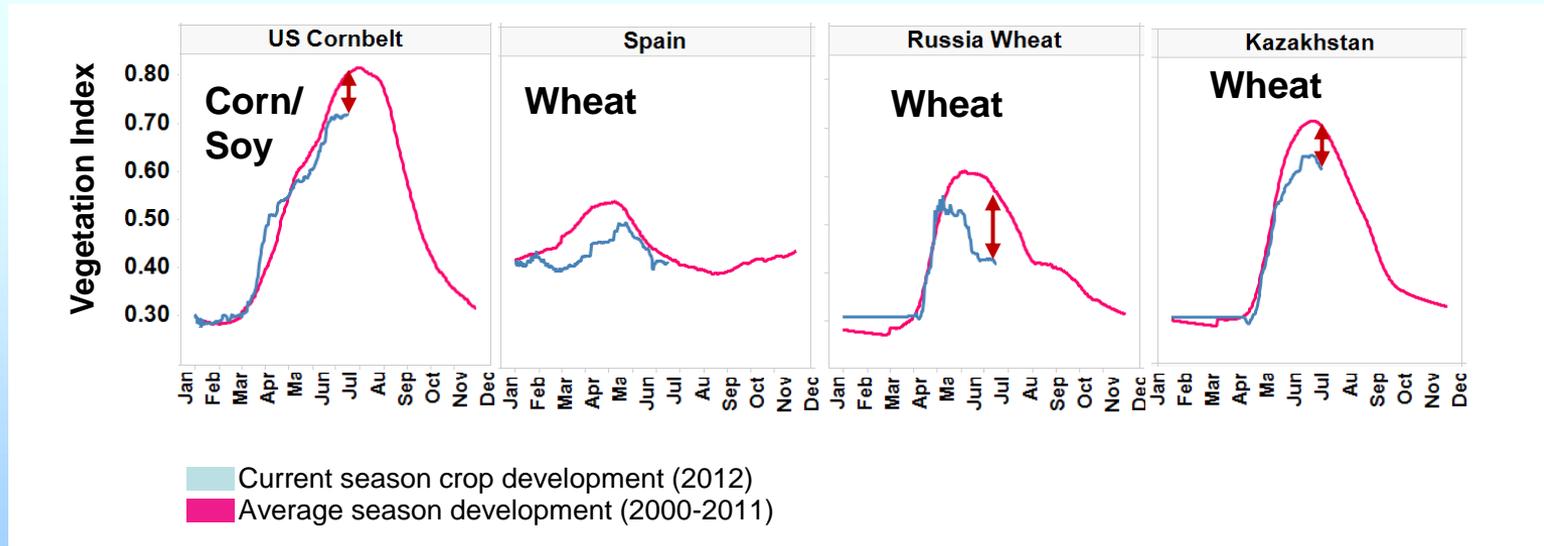


Becker-Reshef, I., E. Vermote, M. Lindeman, and C. Justice (2010a), A generalized regression-based model for forecasting winter wheat yields in Kansas and Ukraine using MODIS data, *Remote Sensing of Environment*, 114(6), 1312-1323.

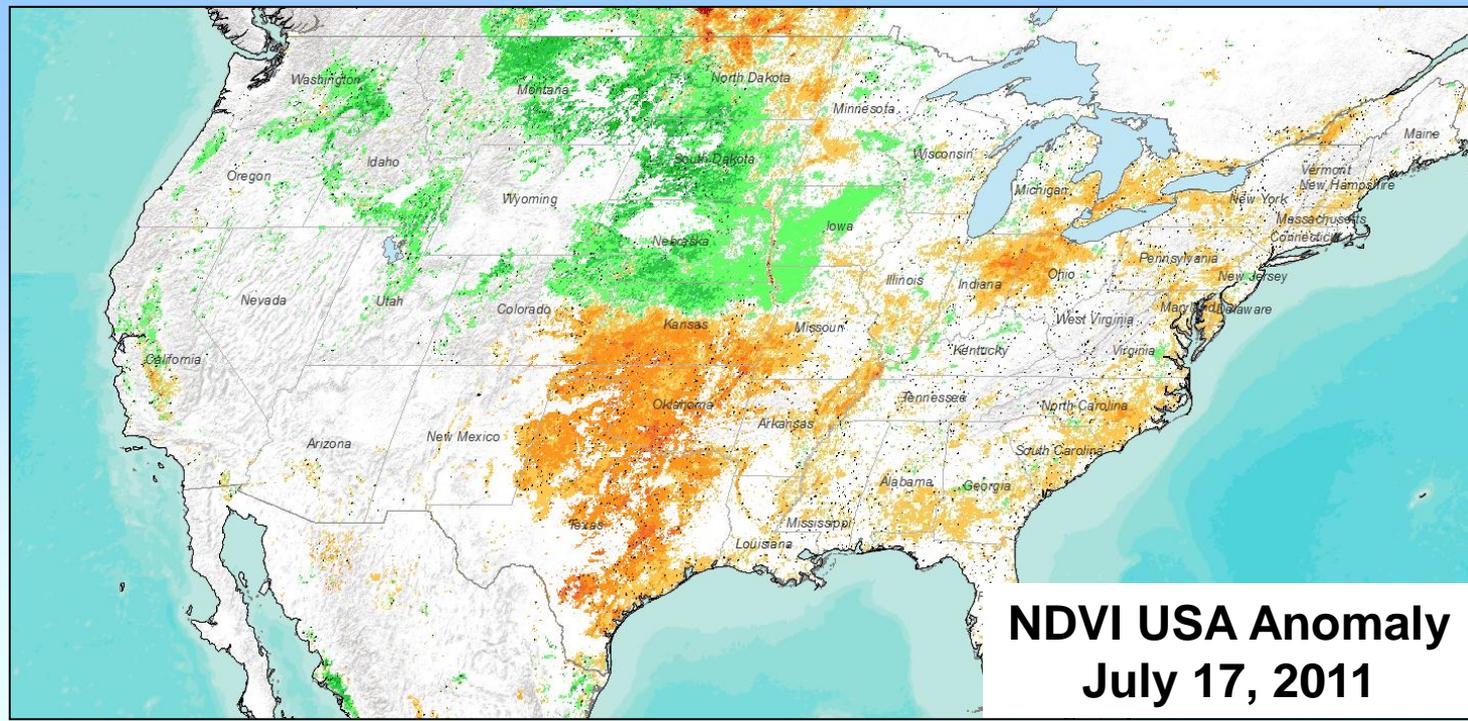
Crop Status in Northern Hemisphere over Agricultural Regions, July 17, 2012



Anomaly

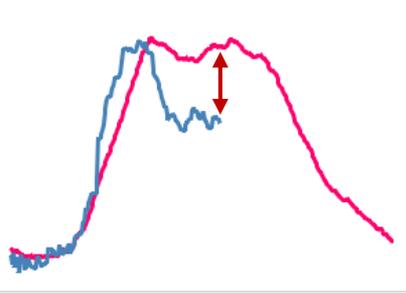


Vegetation Anomaly from last year (July 2011) showing the Texas drought – cf Mike Tanner talk –

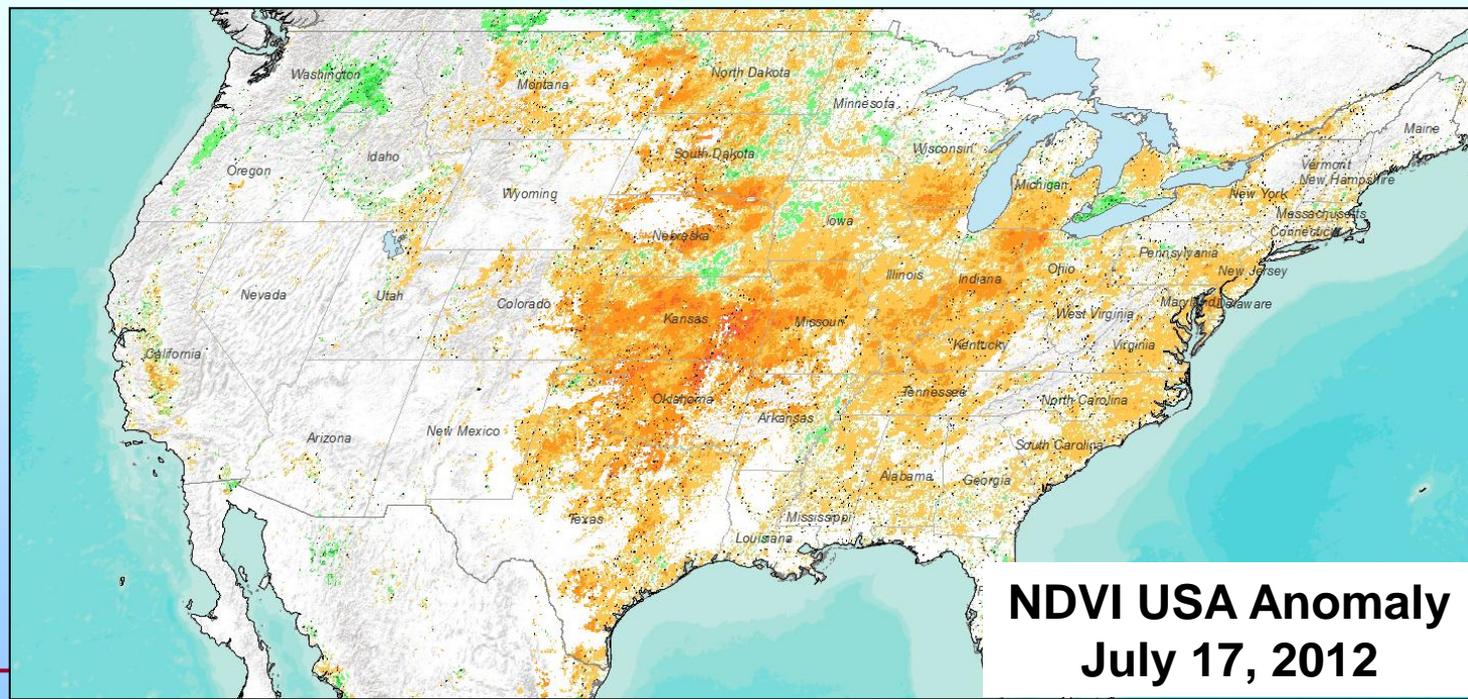


Kansas

Current season 2012
Average season development



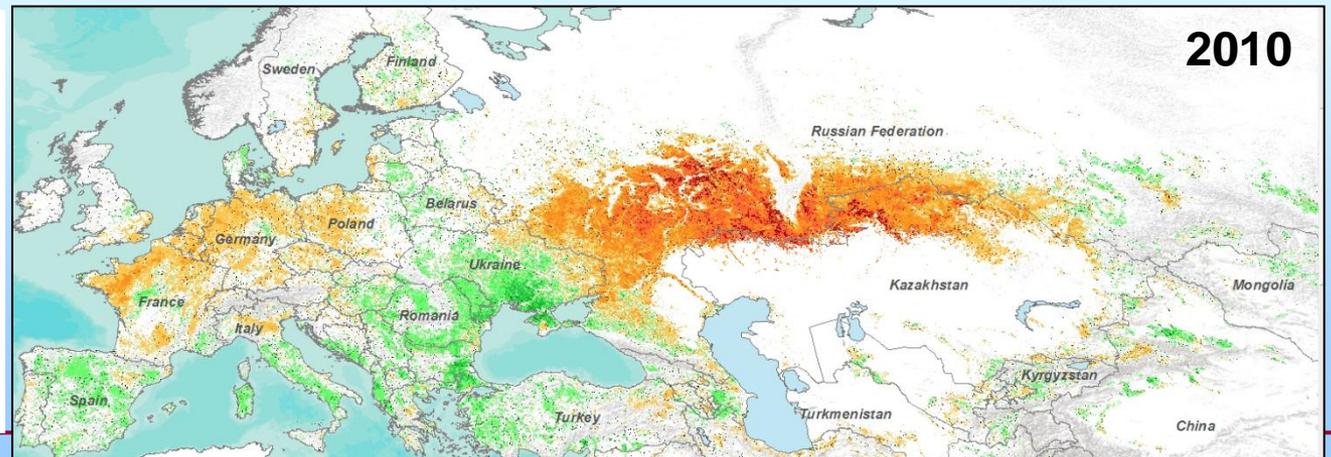
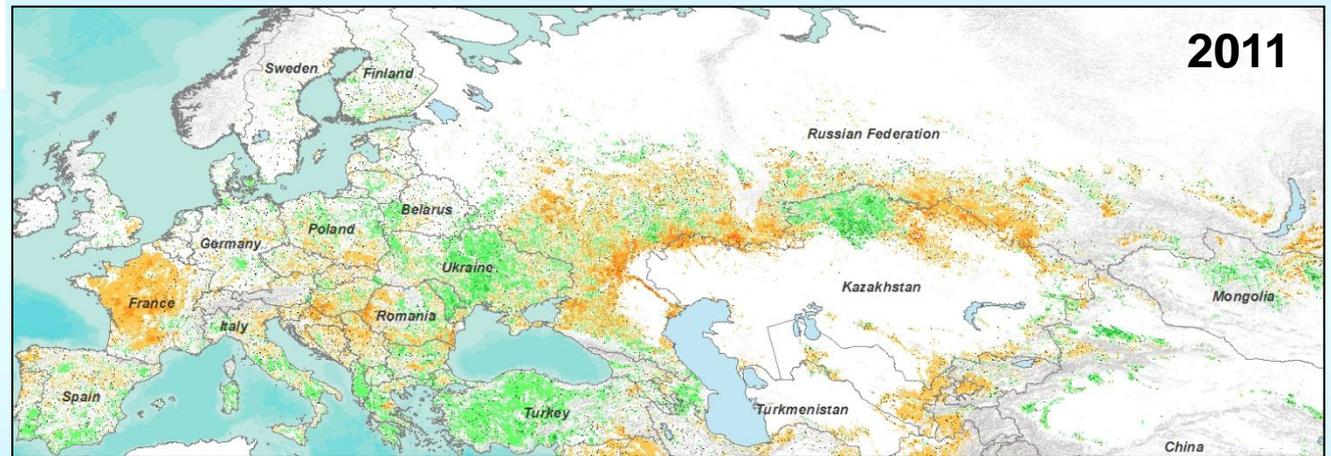
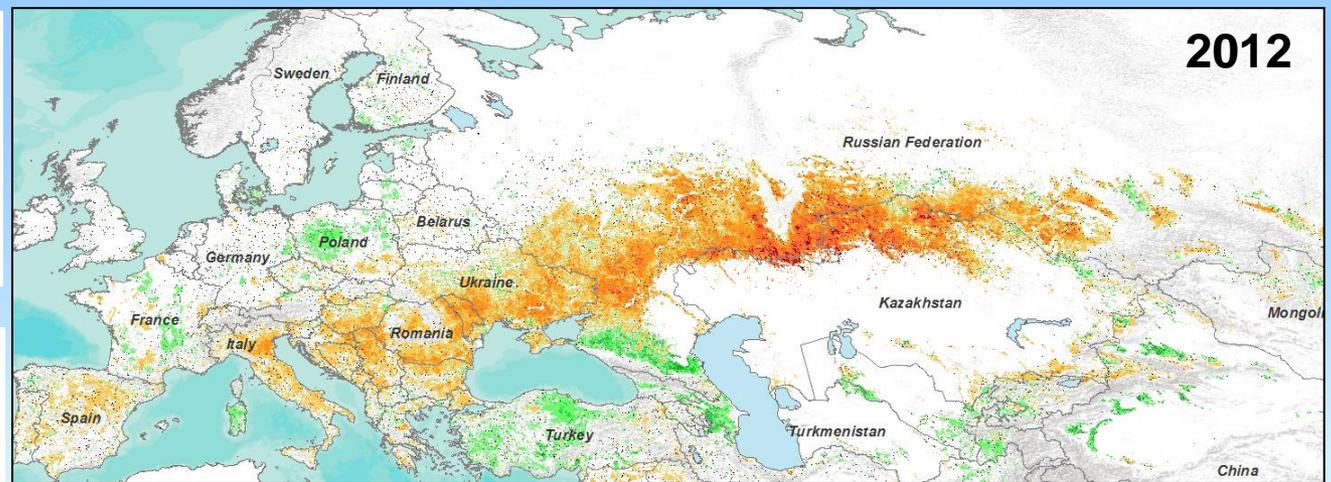
Current drought primarily affecting corn and soy crops



Vegetation Anomaly on July 17 2010-2012 over Agricultural Lands

Current 2012 drought
affecting crop
production in Russia,
Ukraine, Kazakhstan

Vegetation Anomaly
during the 2010 Russian
drought, when grain
production decreased
by 30% and wheat
prices rose over 80% in
6 months



Application to Forest Cover Change

Percent tree cover, Amazon Basin, 1990--Land LTDR AVHRR data



GLFC, University of Maryland, Dept of Geographical Sciences

DiMiceli, C., Vermote, E., Townshend, J., Sohlberg, R., Carroll, M., "A Coarse Resolution Multisensor Time Series of Deforestation in the Amazon basin", Letter to IJRS in preparation



Application to Forest Cover Change

Percent tree cover, Amazon Basin, 2000--Land LTDR AVHRR data



Application to Forest Cover Change

Percent tree cover, Amazon Basin, 2010--Land LTDR AVHRR data



Benefit to the Science Community

- Land cover Land use Change community, Terrestrial Ecology, agriculture application, food security, global vegetation dynamics modelers, carbon modelers.
- LAI and fAPAR are true biophysical variables of the vegetation, useful for quantification of canopy biophysical and biogeochemical processes. The user community of these products includes scientific (modelers of weather and climate, primary production, biogeochemistry, ecology, hydrology, crop production) and a wide range of public/private organizations e.g. meteorological organizations and natural resource managers.
- This long term record (~30 years) enables better understanding of global change dynamics and offering insight into potential mitigation of future impacts.
- Among the user's list several NASA/USDA funded rely on our dataset for their project.

Benefit to Society

- Agriculture / Drought monitoring

Droughts occur and impact humans and the environment across the world often carrying grave environmental, health, economical and social consequences such as crop failures, habitat loss, and social unrest. According to the recent IPCC reports, there is mounting evidence that drought events are becoming more widespread and frequent. The high quality, daily, global data developed in this study can be used to monitoring and track the impact of drought on vegetation, specifically over agricultural areas, and can be used to study the distribution, extent, frequency and severity of droughts over the past decade.